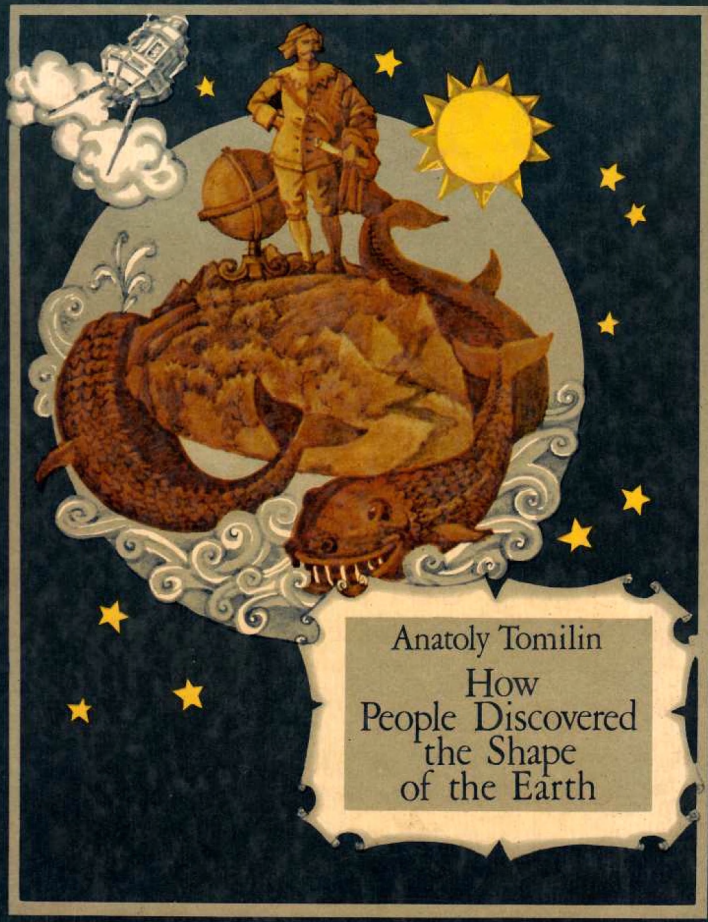
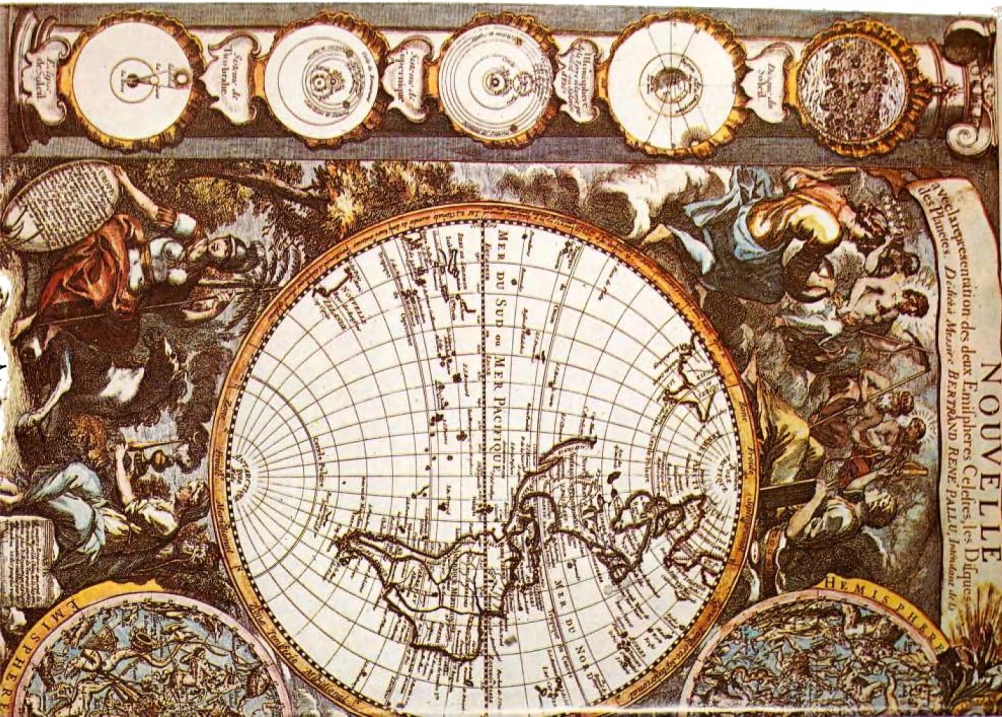


Anatoly Tomilin

How People Discovered the Shape of the Earth

Here you can see the map which shows how different peoples visualised the structure of the Earth in ancient times.



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The original of the map is the property of Mr. Christopher Rainbow.

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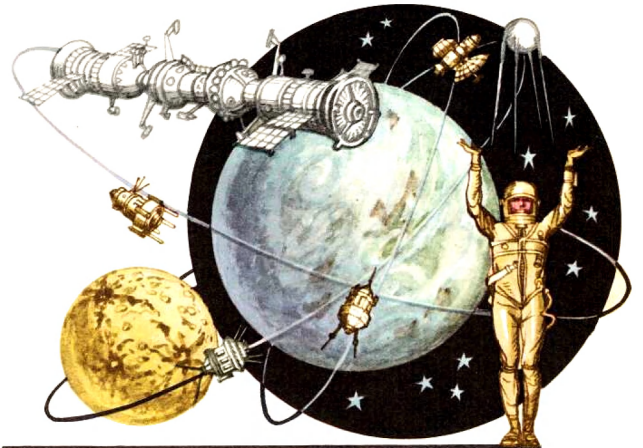
How People Discovered the Shape of the Earth

Drawings by *Yuri Smolnikov*

Translated from the Russian by *Diana Miller*

Raduga Publishers
Moscow





Introduction

What is the shape of the Earth? An odd question, isn't it? The world's a globe. It's round.

To me and you it's obvious. We're 20th century people. The grass is green, the sky is blue and the world is round. We've known it from our early childhood. But is it really all that obvious?

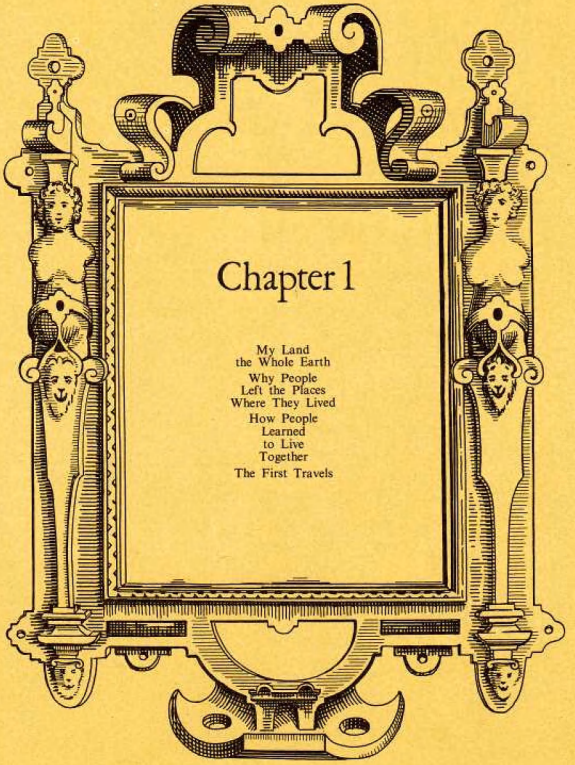
Go out in the country. Walk to the middle of the largest field, till all that you can see is grass and flowers to the far horizon. Does it look round? Can you see the bulge? No. It lies before you flat as a pancake right to the horizon. Every bush and tree, every tiny hillock stands out clearly. So who says the world is round?

When computers were used to calculate the surface of the earth with information from the satellites, it was found that the shape of our planet is not quite so simple. It is slightly pear-shaped. The

Northern Hemisphere is stretched up a bit towards the pole, and the Southern Hemisphere is dented in. There are dents and bumps on its surface. And if you could slice the Earth through the middle at the equator the result would be a circle a little bit out of true. So it's a bit like a pear, and a slightly crooked one at that. What should this shape be called?

Scientists have tried out all sorts of names. Finally they chose "geoid". This is made up of "geo", the Greek for "earth", and "eidos", the Greek for "view". So all it really means is earthlike. In fact the earth is a slightly imperfect sphere. How people found this out is a long and interesting story. And that is what this book is all about.





Chapter 1

My Land
the Whole Earth
Why People
Left the Places
Where They Lived
How People
Learned
to Live
Together
The First Travels



Many million years ago the first people appeared on the Earth. A million is a very big number. If you didn't stop to eat, sleep, to do your homework or anything at all you would have to count without stopping for eleven days, thirteen hours, forty six minutes and forty seconds exactly, counting at a number a second.

In early times, there were few people on earth. Compared with the animals that lived in field and forest, they were weak. They had neither sharp teeth nor claws to defend themselves against beasts of prey nor could they kill game to eat. They had no thick fur to keep them warm, no wings to fly, no long legs to run away from forest fires or spring floods. All that they had was a slightly larger brain and the ability to learn from experience.

Their life was hard and hungry. All day long they gathered roots and grass, went fishing or tried to catch animals, even if only little ones.

People lived in large family groups: mothers, fathers, children, grandmothers and grandfathers, aunts and uncles, nieces, nephews, a whole family clan.

In the evening, having gathered all sorts of things to eat, people would take them to the cave they lived in. There they would sit round the fire, share out the food and eat the lot. Early next morning they would start again. If there was plenty for the day all was well. Tomorrow will be time enough to think about the next day's food.

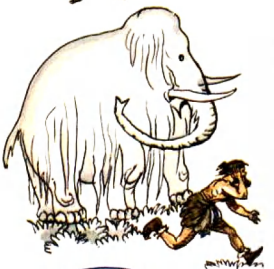
For a very long time, the primitive people could only make their tools for work and hunting out of bone, wood or stone. Making a stone axe or a knife was hard work. First















one had to find the right piece of stone. That could take ages and one might need to go a long way to find it. But no one could go too far from the hut circle, for fear of getting lost. Often they found them in ravines, where fast waters rounded off rock chips into smooth round pebbles, or by the sea-shore.

Sometimes primitive people found stones that could not be split. They could be flattened if they were beaten for a long time between two big rocks. They could fashion this material into a thin strip for a knife or into a cruder bar to use for an axe. And these tools could be sharpened.

Have you guessed? Of course: metal. Copper, gold, or sometimes silver.

Century after century, life flowed by, unchanging. Yet it was changing, but very, very slowly. People gained tiny bits of knowledge from experience. They passed it on from generation to generation. But nobody thought about how big the Earth was then.

Their world seemed so very big. To primitive people without boats, even rivers and lakes were enormous. Their only transport was shank's pony, so the grasslands, forests and plains seemed vast and mountain ranges uncrossable.

How far can you go overland on foot where there are no roads or tracks? It must have been terrifying. Wild beasts lurked in the forest and on the plain, and in the water there were dangerous fish, all waiting to devour unwary people. A traveller might survive, but he would still be frightened. So people kept as near to home as possible. To primitive people their camp and its immediate neighbourhood were their whole world.

Why People Left the Places Where They Lived

Scholars tell us that the earliest people lived in parts of Africa, Asia and Europe. For this is where the earliest remains of primitive man were found. Bones, and crude tools. There have been no similar finds in the Americas or in Australia. Does this mean that people migrated there later? And if so, why? Why did they move? And how did they cross oceans?

There were many reasons. Mostly it was in search of food.

Primitive hunters followed the herds: where the animals went, the people followed. Some families moved to escape from aggressive neighbours. And sometimes the Earth itself drove people and animals away from home.

Scientists have found out that there were several periods in the history of our planet when warm climates became cold and later warm again. We do not know for certain why this happened. Probably the main reason is that powerful forces awoke inside the Earth. Terrible earthquakes shook the Earth and its surface became folded. New mountains rose, and smoking volcanoes. The Earth was torn by deep fractures and gorges. The volcanoes threw up so much ash into the atmosphere that the air lost its transparency. Heavy black clouds hid the sun for a long, long time. and it became colder and colder.

However, some scientists say that from time to time the sun itself shone less brightly, that it gave less warmth. But whatever the cause, glaciers formed in the highlands. The water which evaporated from the oceans turned into snow and covered green valleys with deep snow-drifts. The glaciers in the





mountains became thicker and heavier, so there was less and less water in the oceans. In the shallower parts, the ocean floor became dry land so that land bridges linked the continents.

The longest and severest of these cold periods was long before there were any people on earth. But it was not the only one.

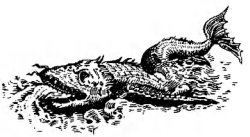
The force of gravity made the glaciers creep slowly down into the valleys. The cold pursued the herds of grass-eaters and beasts of prey followed them, so did man.

Both herds and hunters were able to cross from Asia to America by land. People might also have moved to Australia on the exposed ocean floor of the South China Sea and islands.

The ice ages lasted for thousands of years. But even that is not eternity. Gradually, heavy clouds faded and the sun came through. Its warm rays melted the ice and the glaciers retreated. Again the land was covered with rich green grass and new forests grew up. Large animals began to move back to the fertile meadows: mammoths, rhinos, deer with big antlers, horses and musk-oxen. Again the hunters moved up their camps.

The sun's rays became warmer. Deep, rapid rivers flowed into the oceans. The water rose and flooded the land bridges, and cut off those who had gone from those who had stayed behind forever.

Ice ages, followed by warm periods, happened more than once. And each time animals and people moved north or south away from cold and hunger. Everything was in motion: animals, birds, people. All were moving to new places. Many died on the way, but many survived. And each migration brought something new into the life of man.



Hunting is a good occupation, but it is not very reliable. One day you are lucky. One day you are not. But you need to eat every day What can you do to make the hunt easier?

Well, someone, sometime, managed to tame a dog. Certainly a dog makes hunting easier. For a dog can track down game. Then man goes after it. He keeps the meat and skin for himself, and gives the bones and inwards to his four-footed assistant.

Presently people managed to tame other animals. It cannot have been easy. But in the end, they did it.

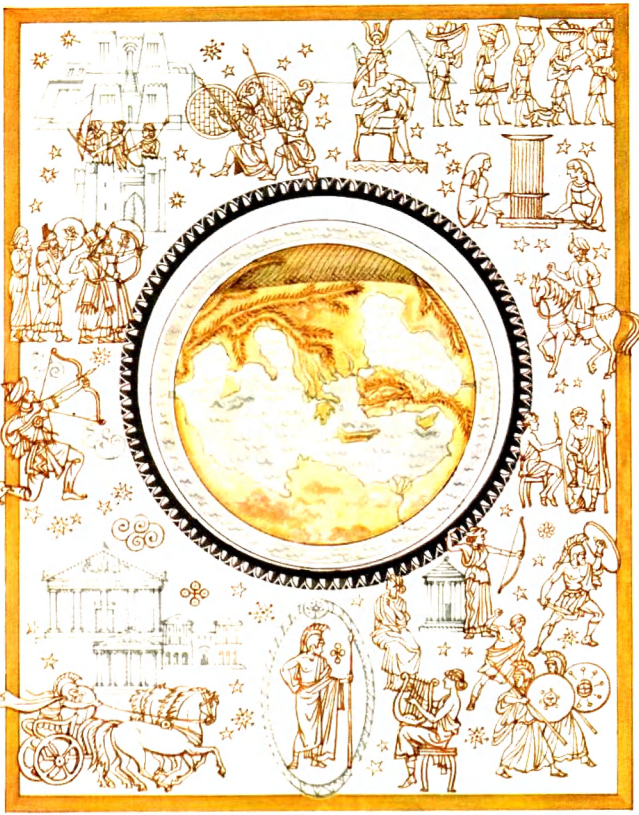
Gathering roots and edible cereals was not always very satisfactory for people could not always find enough nearby. But it happened that women noticed that if they planted seeds in the moist silt along the river banks, the plants grew bigger and stronger than in other places. The ears were larger and the grain was heavier. Also it was easier to pick them, than if you had to look for single ears, because they grow where you plant them. Then people learnt to bury the seeds in silt. The plants grew better, and the birds did not eat the seeds. That is how farming first began. Cattle-breeding and farming made people more prosperous. But it also made life more complicated. Many different things needed doing. Hunting, looking after the cattle, cultivating the land. And making pots and tools and weapons. A small family could not always manage to do it all. So people began to toy with the idea of joining forces with neighbouring families.

Families turned into tribes. In any case, large groups are safer, more secure. But in some ways life becomes more difficult. How should the jobs be shared out in a household? Who should do what? And how should the prey and produce be divided?

People decided to elect the wisest onto a tribal council. Each family was represented by one person so no one was left out. Sometimes, too, several tribes might get together for a big hunt or to fight a war. For farming, though, cooperation had to be more regular. To drain a marsh for a new field, to build a canal or a dam against floods needed united effort. Rivers and lakes take no notice of where people draw on their boundaries. On the upper reaches of a river people may suffer from drought, and on the lower reaches from floods.

Only cooperation will improve the lives of both. It took people a very long time to realise this. But they did learn. Gradually, long, long after man first appeared on Earth, the first states came into being. Of course the whole process was very complicated.

In short, it was necessity that led the way.





Historians tell us that the earliest civilisations sprang in river valleys. When exactly they cannot say. But it seems likely that it was in southern Mesopotamia, in the plain of the Tigris and the Euphrates or on the banks of the greatest Indian rivers – the Indus and Ganges, or in the Nile valley. In these areas people learnt to plough and sow earlier than most others and to water the fields, to measure land and build canals. The people in these places also learnt earlier how to smelt metal out of ore and how to build tall houses.

All places do not have the same natural resources. One area might have lots of ore but hardly any salt. In another it might be the other way round. The people of one town or village produce beautiful fabrics; others specialize in making dishes. So people started to exchange the things of which they had enough and more for things they needed. They brought their wares to one another. That is how merchants first appeared.

They were clever people these merchants. They noticed that those who dared to go far from the beaten track, came back with bigger profits. So the first trade journeys were made. Soon people needed to know where other people lived, what they had much of and what they needed.

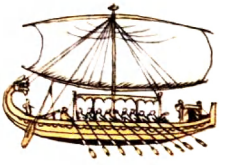
The coast of the Mediterranean Sea was one of the oldest inhabited areas in the world. From time immemorial many different peoples have crowded the Mediterranean shore. The Greek culture originated in this area – one of the oldest, highly developed civilizations on Earth.

The ancient Greeks with their philosophers









and scientists left us a rich legacy. They were also among the first to make maps. They drew the world as a large island with a sea in the middle. The island was surrounded by the stormy ocean, which had neither a beginning nor an end.

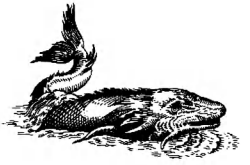
The ancient Greeks called this land-island an "Oykumenus" which means "the land inhabited by man".

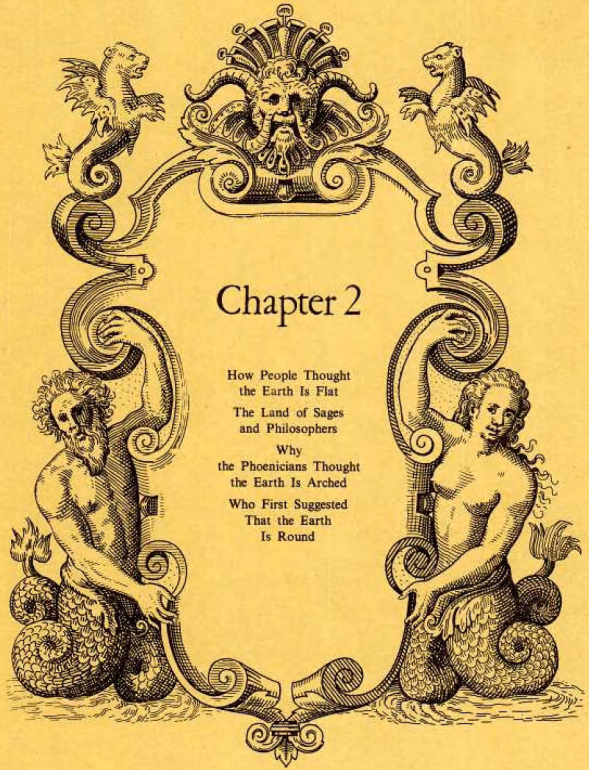
Some parts of Asia, India, China and Britain were also well populated. But thousands of kilometres, mountain ranges and deserts separated them from the Mediterranean. Few people dared to fit out caravans, or loadships with goods for distant lands.

Those who did, returned home to tell about the many wonderful countries and peoples they had seen. Travellers brought back tales about the riches of India, a land "full of gold and jewels", described the steppes, the countless herds of horses and grass taller than man, the superb weapons made of priceless metals by Central Asian craftsmen. And how plentiful the tin stone – so necessary for making bronze – was in distant Britain.

In those times every voyage, every journey was an event.

The names of the brave travellers have been passed down in history. There are many songs and legends about them. For many years stories about their wanderings were passed on by word of mouth. For few things are as fascinating as stories about journeys to foreign lands and foreign peoples. Perhaps it was at such moments that both listeners and narrators wondered, "What is it like, our Earth? Has it any limit, any end?"





Chapter 2

How People Thought
the Earth Is Flat

The Land of Sages
and Philosophers

Why
the Phoenicians Thought
the Earth Is Arched

Who First Suggested
That the Earth
Is Round



The more people travelled on Earth, the oftener they wondered, "What does the Earth look like, what shape is it?"

Scholars believe that the first people who asked this were the sages from the Tien country, which is translated as the Celestial Empire. Have you guessed? It was China, one of the oldest states. China was ruled by an Emperor. From time to time it occurred to a Chinese Emperor to have the borders of his country more accurately defined. For this purpose, imperial officials – guanis and mandarins set out from the capital in all directions. In China, important persons travelled in comfortable carriages. And in each carriage there was a secret instrument which always pointed in the same direction. This made it impossible to lose one's way. The Chinese guarded it and called it "the pointer of the south".

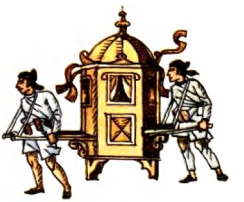
This ancient secret instrument has lived through to our time. Everybody knows how it works. We call it a compass. It is not complicated. It is a little box with a magnetic needle in it. The blue end points south, the red end points north...

For a very long time mandarins' carriages travelled the steppes and deserts. But wherever the Emperor's envoys went, they noticed that in the evening sky the stars always moved from east to west. "Why is this so?" – they wondered. They tried to find an answer, but they couldn't.

Some other officials went to the mountains. Their carriages could not get up the narrow paths. So, they were carried in sedan-chairs. The officials jolting along in their hard cabins were surprised. "Why is one part







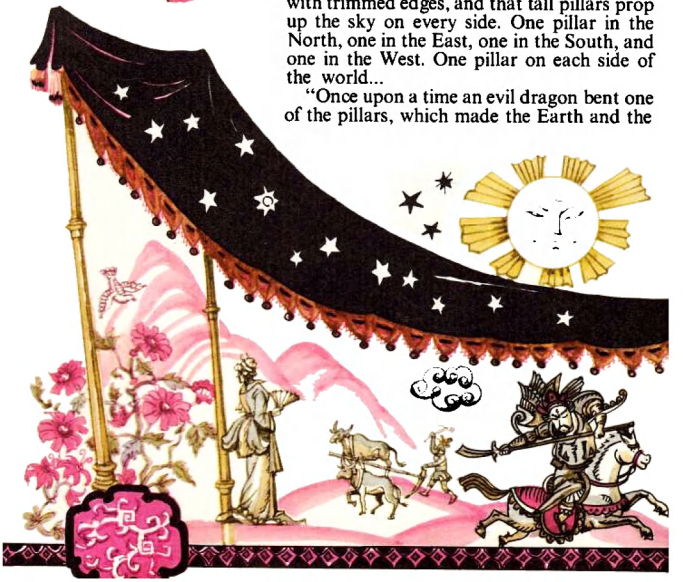


of the Empire so high that reaches the sky itself while the other is low?" They, too, could find no answer.

Still other officials travelled in boats. They sailed on big and small rivers and canals. Servants held umbrellas over their heads and drove away the flies. "Why," the officials asked, "do all the rivers in the Emperor's lands flow from west to east?" They thought about it long and hard. But they could not find an explanation. The court sages racked their brains about these puzzles. And since the Emperor demanded answers to all things, they finally came up with this: "Let us assume that the Earth is flat, like a rice cake with trimmed edges, and that tall pillars prop up the sky on every side. One pillar in the North, one in the East, one in the South, and one in the West. One pillar on each side of the world...

"Once upon a time an evil dragon bent one of the pillars, which made the Earth and the



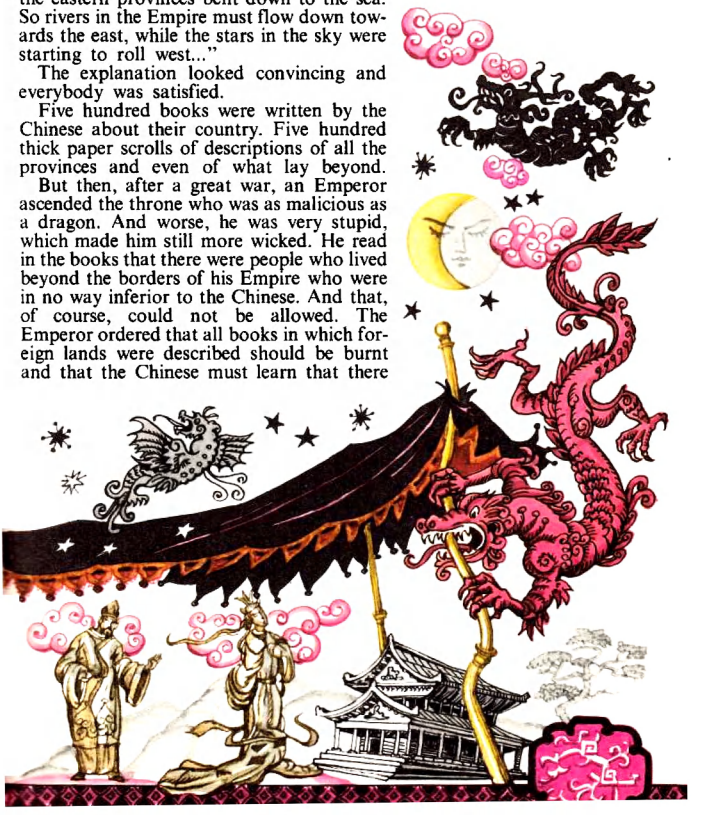


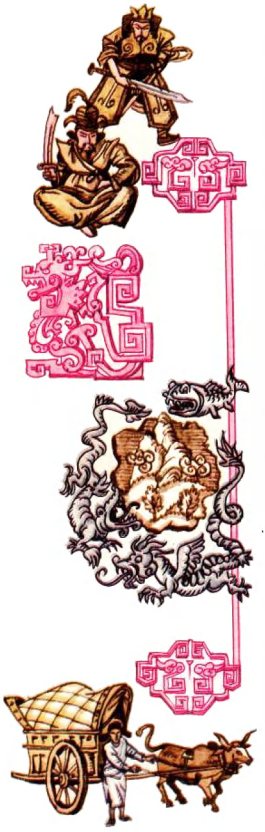
sky bend in opposite directions. The western provinces rose to the sky as mountains and the eastern provinces bent down to the sea. So rivers in the Empire must flow down towards the east, while the stars in the sky were starting to roll west..."

The explanation looked convincing and everybody was satisfied.

Five hundred books were written by the Chinese about their country. Five hundred thick paper scrolls of descriptions of all the provinces and even of what lay beyond.

But then, after a great war, an Emperor ascended the throne who was as malicious as a dragon. And worse, he was very stupid, which made him still more wicked. He read in the books that there were people who lived beyond the borders of his Empire who were in no way inferior to the Chinese. And that, of course, could not be allowed. The Emperor ordered that all books in which foreign lands were described should be burnt and that the Chinese must learn that there





was nothing interesting beyond their borders. The Emperor even renamed China. The Flowering State in the Middle. From that time on, this is what the Chinese have called their country, though much of it is far from fragrant or flowering.

The working people lived in poverty, troubles and sorrows. Only the officials and the rich were carefree and happy. But that often happens in the world – the more rotten things are the more magnificent the words.

The officials zealous in the service of The Celestial, as they called the Emperor, made sure that his subjects would not want to poke their noses over the border. So they gave China another name: The Four Seas. They said that China was the world. The whole world was China, which was surrounded on all four sides by stormy seas, teeming with huge fish and great big dragons. People believed and stayed at home.

Well, most people. But not quite all. Some stories and descriptions of journeys to distant lands made by ancient Chinese have come down to our time.

Officers travelled on horseback, diplomats in heavy carriages, spies made their ways by secret paths. Monks walked and merchants' caravans sometimes stretched for miles. When they reached the unknown lands in Central Asia, Chinese travellers were astonished to find civilised people there, people like themselves. People who cultivated the land, and made tools, wove fabrics and turned pots. The Chinese took goods with them to sell in distant western countries. But the local peoples also had things to sell. And many of their goods were no worse than Chinese goods. Those who went south, across the mountains, found themselves in a wonderful country called India, where many sages and philosophers lived.

Ancient India did not get this name for nothing. At the time when civilisation was just beginning in the neighbouring countries, there were many learned people on the huge Indian peninsula, which stretches like a tongue down into the blue-green Indian Ocean. The Indian subcontinent was divided into small principalities which were continually at war with one another. Every Rajah's court had its own sages and thinkers, and they were highly respected.



There were mathematicians and astronomers, doctors and plain philosophers, the fount of wisdom, for they loved to ponder over incomprehensible questions. The Indians called them Great Sages.

What did these Great Sages think our Earth was like? They were by no means all agreed. Most thought that the Earth was flat. Not like the Chinese rice-cake with cut edges, but a huge flat disc with the mountain Meru







in the middle. The sun, the moon and the stars revolved around the mountain. So far they all agreed. Some thought that the dry land was divided into four continents, separated from Meru and from one another by oceans. Each continent was named after a huge tree that grew on the coast. The southern continent, the only one where people lived, was called Jambudwipa after the jambu, a pink apple-tree.

Other sages disagreed. They said Jambudwipa was shaped like a ring, around the high Meru mountain. Next came a salt ocean and then another ring-shaped continent. The far coast of this second continent, they said, was washed by an ocean of syrup. All told, there were seven ring-shaped continents in this model of the Earth. Each ring was separated from the last by a different ocean. The syrup ocean was followed by the ocean of wine, then came the ocean of boiled butter, then cream, then sour milk and finally fresh water...

Now who would dare deny such a magnificent picture of the world?





And yet there were people who disagreed. One group said the Earth is like an open lotus flower. The four biggest petals are the four continents. The pistils and stamens are the mountains which surround the valleys of the Ganges and the Indus rivers. The lotus grows in a boundless ocean and its stalk is attached to the ocean bed.

This picture did not satisfy all the sages. Still others had a model of their own. They believed that the world is an enormous turtle floating in a huge sea of milk. Could anything be more solid? Four elephants stand on the turtle's back. Could anything be stronger? With their trunks raised in the air, the elephants face the four corners of the world, holding the flat, round Earth on their mighty backs.

The ancient Indian sages really had the most amazing models of all.





Why the Phoenicians Thought the Earth Is Arched

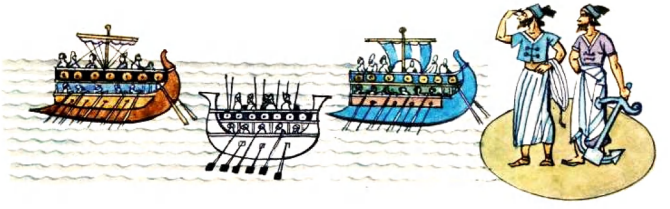


The Phoenicians were most unusual people. And they lived in an unusual country. For strictly speaking there never was such a country. The ancient Greeks gave this name to a narrow coastal plain squeezed between high mountains and the Mediterranean Sea. Today it is called Lebanon. In many places the mountains come right down to the jagged shore, dividing the land into small sections. Fast rivers water the land and make the valleys very fertile. But there was never enough land. From olden times these small settlements had crowded together and as time went on they merged into cities, each of which was an independent state. The Phoenician cities did have geographical advantages. Many trade caravans went from there to Mesopotamia and the Nile valley and their ships sailed to many lands on the Mediterranean shores.



Century after century more and more Phoenician ports and trading colonies grew up on these shores. Some became powerful independent states. Carthage was one of these. Phoenician craftsmen made superb purple dye with which wool was dyed for only the richest noblemen. They worked







metal, too, made ornaments and dishes out of glass. No one could build better ships than the Phoenicians. They used the biggest, strongest cedars to make wide hulls. Then they added planks to protect them against the waves. Their oarsmen were helped by sails fastened to tall masts. These ships carried crews of up to thirty. They were brave seafarers, the Phoenicians, who feared neither god nor devil, thunder or storm. The Phoenician helmsmen knew every route in the whole Mediterranean, and some went well beyond it. In the 7th century B.C., the Egyptian Pharaoh Necho II sent out a fleet down the coast of Africa. He ordered the ships to sail on until they came to an impassable barrier before they turned back. The fleet was away for three years. They sailed right round the continent and returned home from the opposite direction.

Even now we still have the descriptions left by two Carthaginian commanders, Hanno and Hamilcar, of their voyages in the Atlantic. Hanno went south along the African coast; Hamilcar sailed up the European coast and reached the British Isles.



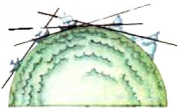


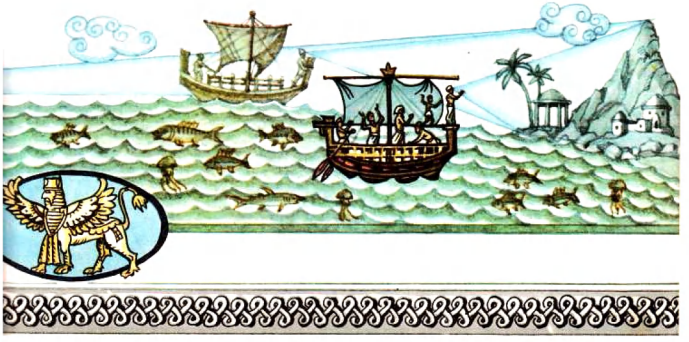
When sailors return after a long voyage they look forward to the first glimpse of their native shore. The Phoenicians were no exception. But they had noticed something. Their first view of their shoreline was always the peaks of the highest mountains coming up out of the sea. Then, as they came nearer to the shore, more and more of the mountains rose up into sight. Finally the city buildings hove up out of the water like dolphins.

This made the sailors wonder. For if the Earth was flat, they should see all of it at once. Were they mistaken then, these people who said the Earth was as flat as a pancake? Surely it must look rather more like half an apple. For if the world were curved then obviously the mountain peaks would be the first to rise up out of the sea. It would explain, too, why one can see farther from the mast-top than from the deck.

So the Phoenician seafarers believed the world was curved like half an apple or orange lying in a saucer of water. The water was the sea and the edge of the saucer held up the upturned blue basin that was the sky. A strange model, is it not?





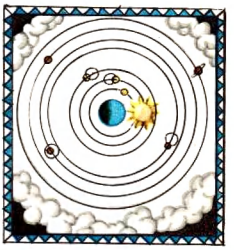




It is hardly possible to be certain of the answer to this question now. In ancient times every civilised country had its sages, and the idea must have occurred to many of them. Pythagoras, for instance, a thinker from Ancient Greece believed the sphere to be the most perfect of all geometric figures. So, given that our world was the centre of the universe, how could it be any other shape? Many scholars agreed with Pythagoras. The only question was how to prove it. What reasoning or examples could be put forward that would dispel all doubt? The Greek philosopher Aristotle proved it. He was a very learned man, with a great deal of knowledge in many areas of science. He was the tutor of Alexander the Great, had founded a famous school in philosophy, and his fame had brought him many students and disciples. Even when he was at the height of his fame, Alexander never forgot his teacher. He used to send him letters and rare or curious things that he came across from many countries.

Like every true scholar, Aristotle always wanted to know still more. Knowledge is the kind of wealth that no one need be ashamed of collecting.

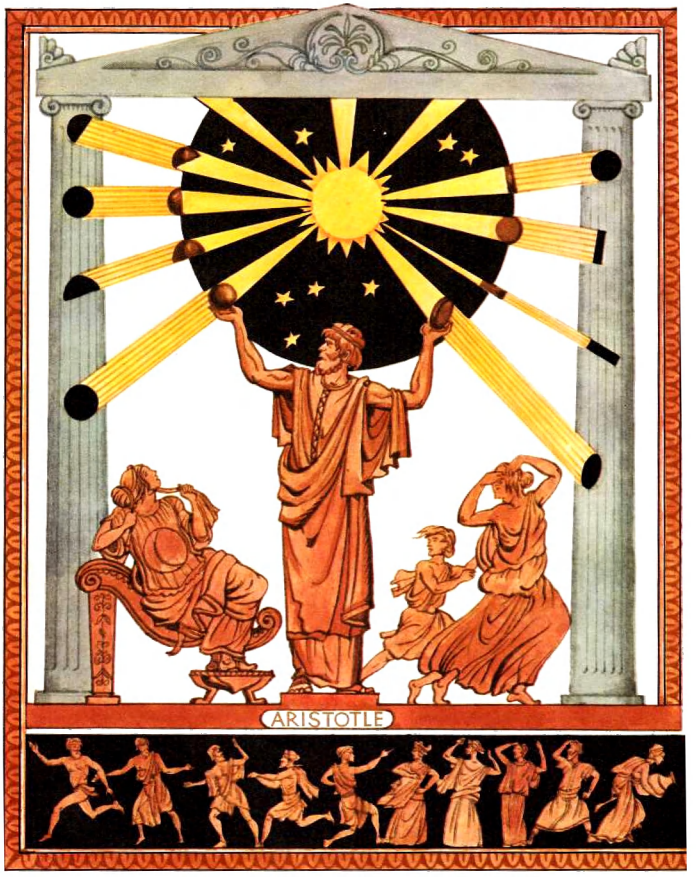
One of the mysteries still unsolved in Aristotle's time was the eclipses of the moon. Nobody knew why they happened. Some people thought that wicked giants took the moon away to steal its silvery light. Others believed they were a portent of disaster – of war and famine and plague. Some people told stories about an eclipse poisoning the air, that people could be asphyxiated by it. The credulous hid in their cellars, covered










ARISTOTLE

their windows and filled in the cracks with clay or putty.

Aristotle was no coward. He had observed eclipses more than once and nothing had happened to him. His observations led him to the conclusion that the dark spot on the moon was the shadow of the Earth when the Earth got in between the sun and the moon. But why was the shadow always round?

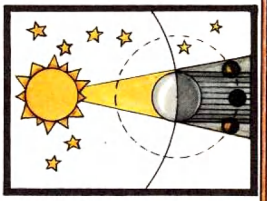
Aristotle held up a flat round cake in the sun and looked at its shadow. In one position the shadow was round. In another it was as thin as a rod. So the Earth could not be flat.

Then he held half an orange in the sun. This cast a round shadow if the sun shone on the flat or curved side. But as soon as it was turned sideways, the shadow was a semicircle.

Only a whole orange always cast a round shadow.

"That means that our Earth must be round," Aristotle told his students. And he showed them how he had arrived at this conclusion. The









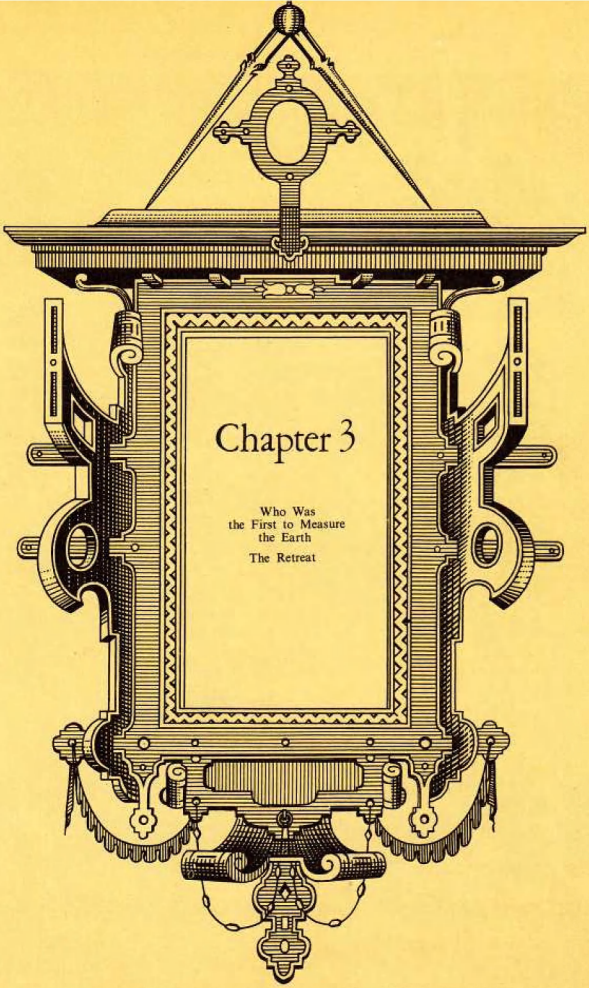
students looked at their teacher, wide-eyed and amazed by his wisdom.

But one problem remained. How could people live in the bottom half of the world. They would be upside down. Would they fall off?

Even Aristotle could find no plausible answer for at that time nobody knew that it is the force of gravity that holds things to the Earth. Not just the people but the mountains, houses, rivers, oceans. Even the air.

Since Aristotle did not know that, he and his disciples assumed that the Southern Hemisphere would be uninhabited. Some scholars took the view that there might be antipodes living there.

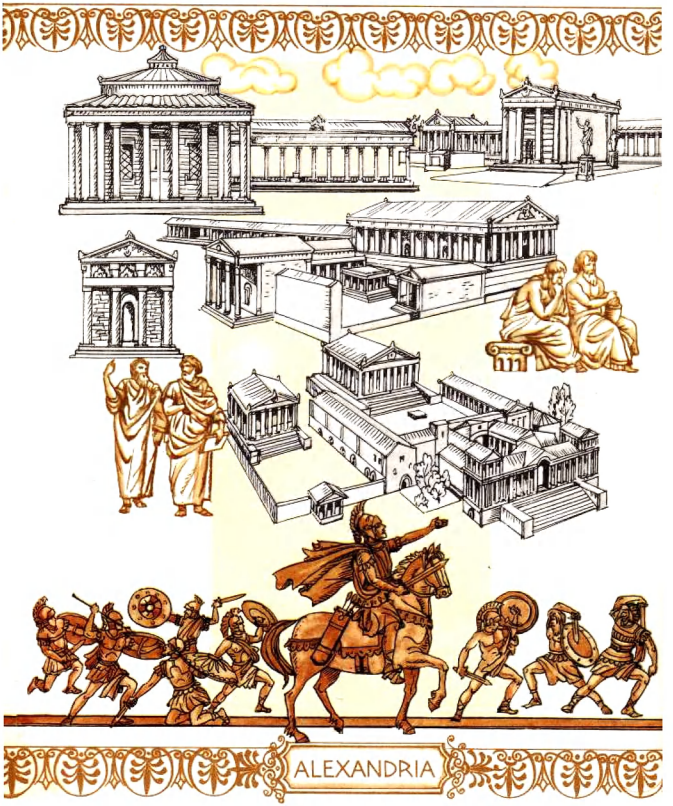




Chapter 3

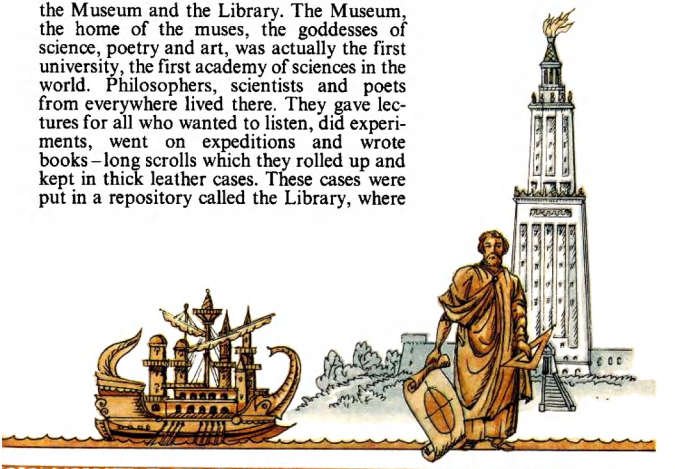
Who Was
the First to Measure
the Earth

The Retreat


ALEXANDRIA

Alexander the Great marched half-way round the world with his armies. In Egypt he ordered that a city be founded on one arm of the Nile, at a point where many trade routes crossed. The city was called Alexandria. Years passed and people liked the place. There was never a shortage of people wanting to live there, so the city grew and grew. Newcomers were surprised by its wide streets and its houses several stories high built of unfired brick.

But the real wonders of Alexandria were the Museum and the Library. The Museum, the home of the muses, the goddesses of science, poetry and art, was actually the first university, the first academy of sciences in the world. Philosophers, scientists and poets from everywhere lived there. They gave lectures for all who wanted to listen, did experiments, went on expeditions and wrote books – long scrolls which they rolled up and kept in thick leather cases. These cases were put in a repository called the Library, where







hundreds of thousands of manuscripts accumulated.

In the third century B.C., a geographer and astronomer called Eratosthenes lived in the Museum. He was one of the first directors of the Alexandria Library.

Eratosthenes became famous for two things. For his geographical description of all the countries known in his time, and above all because he calculated the size of the earth. This is how it came about.

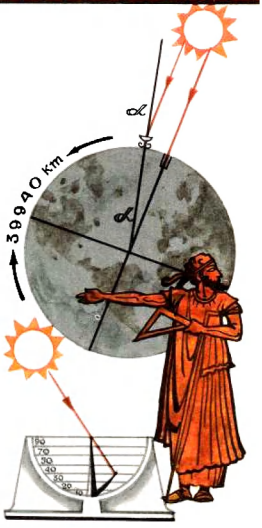
The merchants who arrived from Syene told him that at noon on the day of summer solstice – the longest day in the year – the sun rays lit up the water at the bottom of the city's deepest well. This showed that they must be exactly vertical. Eratosthenes knew that the distance between Syene and Alexandria was five thousand stadia from south to north. The distance had been measured by caravan guides. Now on the same day in Alexandria the angle of inclination of the sun's rays was a fiftieth of the angle of a complete circle. So Eratosthenes knew that the distance between the two cities must be a fiftieth of the circumference of the Earth. Hence Eratosthenes multiplied five thousand stadia by fifty, which made two hundred and



fifty thousand stadia. That is, some 42 to 43 thousand kilometres. Now the length of a meridian running through the two poles is, as calculated in our time, 39,940 kilometres. Eratosthenes' error was negligible.

Not many of Eratosthenes' works have survived. What we know about him has come to us through other, later writers. From them we know that he wrote an outstanding book which he called *Geographica*. In classical Greek that means a description of the Earth. Eratosthenes divided his book into three parts. The first was a history of geography. In the second he gave the basis of mathematical geography. The third was a description of the land based on the most recent evidence.

Like all Greek philosophers, Eratosthenes paid the most attention to the Mediterranean area which the Greeks believed was a big island, surrounded by ocean in the temperate zone of the Northern Hemisphere. The tropical zone was believed to be uninhabited because it was too hot. As for the temperate zone in the Southern Hemisphere, the ancient scholars did admit that there might be unknown lands there, inhabited by antipodes.






One of Ptolemy's maps.
Scientists think that he was the first among ancient scholars to have drawn longitudes and latitudes on the map of the Earth.

According to the Ancient Greeks the outlines of their "land island" were similar to a Greek man's garment made of several rectangles of different colours. The philosophers divided the land into three parts, Europe, Asia and Libya. It was only much later that the Romans, not the Greeks, gave Libya a new name, Africa, after a powerful tribe, the Afrigeers who lived there.

How did sailors find their bearings? People must have known the distances in stadia, or by how many days' travel from one point to another. To make the choice of route easier, Greek geographers drew lines on map through places that the traveller might know. One of these lines, "the diaphragm", started at the Pillars of Hercules (the Strait of Gibraltar) across the Mediterranean to the Strait of Messina and the southernmost part of the Peloponnesus towards the Island of Rhodes and along to the southern end of the Asia Minor range. The diaphragm was parallel to the equator and divided it in half. Another line intersected it. This began in the south, in the kingdom of Meroe (now part of the Sudan) and headed up the Nile valley to Alexandria, then through Rhodes and Byzantium to the mouth of the Dnieper. These lines were a great help in map-making.

Later other parallels were added, drawn through important places. In the second century A.D., Ptolemy, the famous mathematician, astronomer, geographer and meteorologist covered the whole map with lines of a longitude, parallel with the equator, and meridians that passed through the North Pole.

Ptolemy did not agree with the scholars of his own time that the land was an island. He doubted the Phoenician sailors' evidence and said that no one could be really sure that there was no land to the north and the south. So when Ptolemy made his map of the world, he took the land right to the edge and wrote in "unknown lands".

He would not hear of any ocean to the north or south of Asia or of an ocean south of Ethiopia. Scholars have reconstructed his map from his descriptions. The Indian ocean is shown as an inland sea and South-East Asia is linked to East Africa by an unknown land.

So who was nearer the mark? If it was Eratosthenes, seafarers could get to even the most distant lands by sea. If it was Ptolemy, their ships were land-bound and really long journeys had to be made by land.

Ptolemy was the last of the truly great scholars of classical times. He lived in an epoch when Greek culture was already on the decline. The pagan beliefs were giving way to newer religions. The flat earth theory was again becoming widespread in Europe. It was a big step backward.



I have a very big book in my bookcase at home. It is hand-written in old letters in the Old Slavonic language. The title is *A Book About Christ Which Embraces the Whole World*. It was written in the 6th century A.D. by a Greek merchant called Kosma, often called Indikoplov. This was a very honourable name, for it meant that he had been to distant India.

Kosma travelled a lot as a merchant. When he was old, he became a monk and he wrote a book on the way the Earth works. His description was based on the Bible, the Christians' sacred book. He accepted the biblical idea that the Earth is a flat rectangle, washed by ocean on all sides. The ocean is surrounded



by high walls that support the firmament, a hard, transparent dome, on which the angels roll the stars around.

And Kosma reasoned that the heavenly waters must be stored behind the firmament, because from time to time they spilled on us as rain. To the north, he placed a high mountain behind which the sun hid as it circled the sky. Thus night descended all over the world.

There are many pictures in the book. Russian artists copied some of them from the Greek original. For others they used their own fantasy. Writing about the countries he had visited, Kosma described both things that he had seen with his own eyes and things he had only heard about. So side by side with pictures of camels, oxen, elephants, one finds imaginary creatures such as wild-boar-elephants, unicorns, and nostrilocorns...

Nobody knows exactly when this book first reached Russia. The translator is unknown. It was certainly very long ago. People in all countries liked to read or hear travellers' tales. Russians who could read liked this book by Kosma, the merchant from Alexandria. Why would they like it if so much of it was pure invention? Because people did not know this, they believed every word. And then, his stories made them want to travel to those distant lands.

There were many books in medieval Russia that described other lands and how the world went together. There was a book called *The Deep Book* – "deep" because of the deep wisdom it contained.

In it, the mythical sage David Evseyevich tells how the Earth rests on a huge whale and that every time the whale turns, the whole Earth stirs.

The Arabs were the most intrepid travellers of the Middle Ages. By the seventh century they had conquered an enormous territory. Then they took to trade. Arab merchants visited Eastern Europe, all the Slavonic lands and Central Asian countries. They were the first to tell about the wonderful lands in Africa south of the equator. They told Europe about the tropical countries in East Africa and about Madagascar.



In the ninth century, a learned Persian, Ibn-Hordabeh, put together all the geography known in his time in a manuscript that still exists. He called it *The Book of Routes and Kingdoms*. He did not travel much himself, but as he was at the Khalif's court, he could use all the information from Arab travellers, merchants and officials.

Some time later Ibn-Rushd wrote a book. He was a traveller himself and wrote of what he had seen with his own eyes. He called it *The Book of Precious Stones*. Only the last part has survived, about a seventh of the manuscript, which is mainly about the peoples of Eastern Europe. Ibn-Rushd wrote about the Slavs and Kievan Rus (as medieval Russia was called) about which little was known in Western Europe or South-West Asia.

In the tenth century, Ibn-Fadlan wrote a book called *A Journey to the Volga*, which added to this knowledge.

Masudi, a native of Baghdad, had been to every country in the Near and Middle East, in Central Asia, the Caucasus and Eastern Europe. He travelled through South-East Africa with caravans, and knew both China and Java well. He wrote two books *Golden Meadows and Diamond Fields*, and *Reports and Observations*.

I could tell of many medieval travellers who left us valuable works. For instance, about the Khorezmian scholar Al Biruni or about Ibn-Batuta, the greatest traveller of all peoples and all times, who covered at least 120,000 kilometres in 25 years of travelling.

The Moslem travellers and geographers also believed that the Earth was flat. But unlike the Christians, who thought it was a rectangle, the Moslems thought it was round. That is how they drew it on their maps. I shall tell you about one of these.

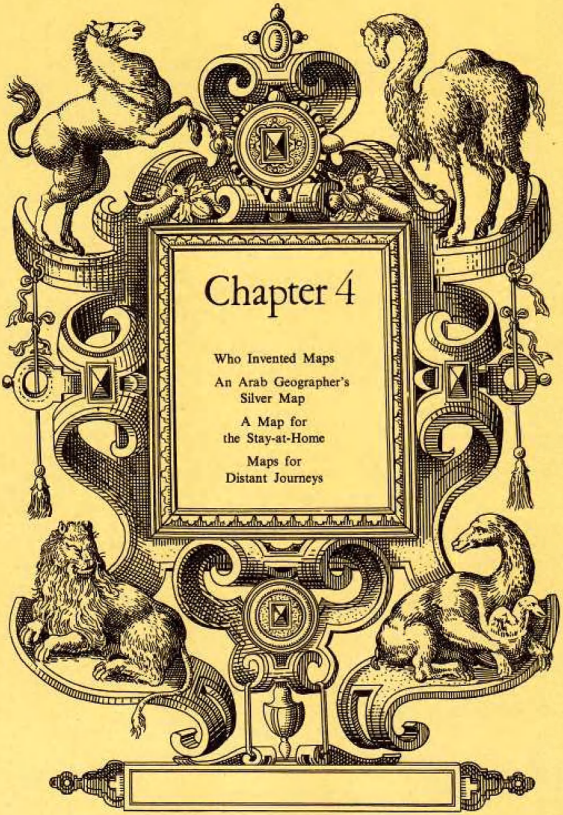












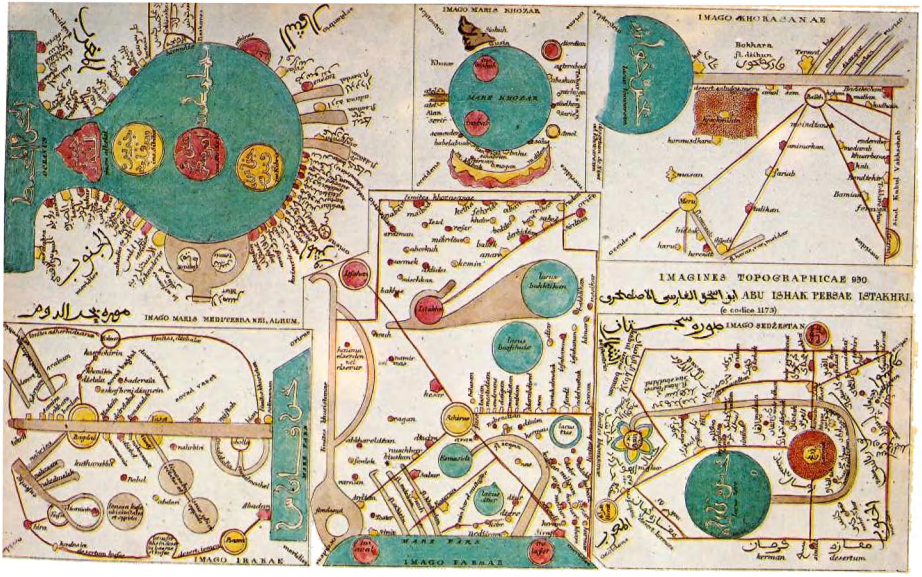
Chapter 4

Who Invented Maps

An Arab Geographer's Silver Map

A Map for the Stay-at-Home

Maps for Distant Journeys



12th century map

People could draw plans of their immediate neighbourhood from very early times. How else could one explain which place was best for hunting or where the sweetest roots were found? Later, these early geographers began to mark neighbouring settlements in their plans, linking them to their own with small lines, to show the tracks and paths. When the first caravans set out, the time had come for plans and descriptions of caravan routes.

The Ancient Greek philosopher Anaximander who lived in the sixth century B.C. put together many such descriptions and tried to draw a plan of the world. That was probably the first real map.

Making a new map is a very interesting thing to do. As a child I always liked drawing mysterious uninhabited islands. I filled the mountains in brown – they normally are. The lakes and rivers and the sea I painted blue, and the lowlands – mine were always covered in impassable jungle – were green. The jungle was always full of fierce animals, more dangerous than the lions and tigers in the Zoo, indeed much fiercer than any real animal. My islands were ideal for hunting, for rescuing beautiful princesses or finding treasure guarded by poison snakes.

When I grew up I learnt that people had drawn maps long before they could write. The people who did this were called land-surveyors.

In the Soviet Union, not far from the Black Sea there is a town called Maikop, which is only about a hundred years old. It is on the Belaya River. Nearby there is a barrow. Nobody remembers when or why it was made. One day some archeologists suggested excavating it. They said there might be things in it that could tell us something of what once happened here. Well, no sooner said than done. An expedition was fitted out and they began to dig. The first day they found nothing. Nor on the second or the third, except many shovels full of soil and sand and stones. The archeologists were disappointed and were already wondering if they should give up when suddenly they found a treasure.

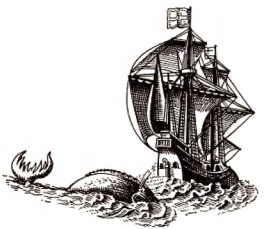
And what a treasure! A tomb with a rich canopy embroidered with golden plaques, covered in earth. The canopy rested on four silver pillars, each ending in a silver and gold figure of an ox with crumpled horns. Nearby, they dug out beautiful gold and silver vessels, and jewelry. And tools and weapons made of stone and pure copper. It was indeed a treasure!

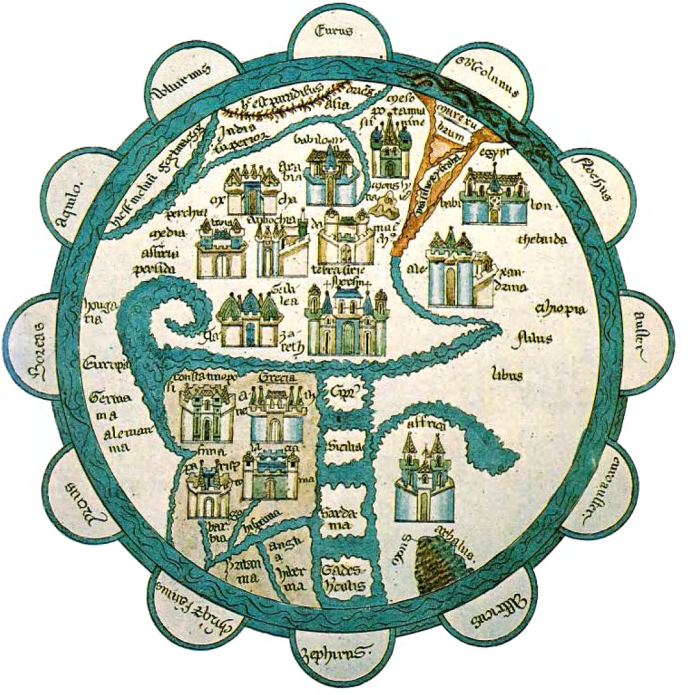
It must have been the tomb of a rich and powerful tribal chief. Perhaps he died of old age, perhaps he was killed fighting enemies. He was obviously a highly respected person, for his companions had buried him with great honours.

The archeologists were less interested in the gold and silver than in some ceramic vessels with pictures all round. They had probably been used for storing oil or wine, and unknown artists had drawn the Caucasian mountains and a nearby river so accurately and with such detail that the archeologists had no difficulty in finding the places.

The most surprising thing of all was how old the vessels were. They were at least four thousand years old! The tribes who lived in this steppe-land then could probably not read or write, but they could certainly draw maps.

Not long ago some archeologists excavating an old settlement in Turkey found a map scratched onto a clay plate. It is believed to be nine thousand years old. This is the oldest map that is known. But who knows. There might well be an older one that has not yet been found.





14th century map

An Arab Geographer's Silver Map







Sicily is a big island in the warm Mediterranean Sea. In the city of Palermo lived an Arab geographer and scholar. His name was Abu Abdallah Mohammed Ibn-Idrisi and he was the son of a rich prince. He studied for many years and he travelled a great deal. He became known as a very wise man.

The King of Sicily, Roger the Second, held court in Palermo. King Roger came from Normandy in North-Western Europe, but his father had brought him to the warmer clime of Sicily. King Roger knew the northern countries well and was proud of this. Also, he liked geography. (Don't most of us like the things we are good at?) The king heard of the learned geographer. People said that no one knew southern lands better than he. So Roger told his people to invite Ibn-Idrisi to the palace and suggested that they should draw a map together. King Roger knew the northern and Ibn-Idrisi the southern lands. So that between them they could draw the biggest, most accurate and most detailed map of the inhabited world.

Ideas and knowledge are wonderful things. They are like the "unspendable coin" in the fairy-tale you can use again and again but you can never spend it.

There is an old saying: if you and I each have an apple and we swop, we will still have one apple each. But if you and I each have an idea and swop, we will each have two ideas.

Ibn-Idrisi agreed to work with the king. For then each of them would know twice as much.

Then the king asked what material they should use for their great map. Surely paper was too ordinary. And in any case it does not last forever. We do not know what the Arab scholar said. But we do know that the king ordered that all silver from his treasury be melted down and beaten into the biggest round plate the silversmiths could make. (Remember, Arab geographers believed the world was flat and round). Then let wondrous map be impressed on it forever!

A king's word is the law. The silversmiths got busy. When the plate was made, it took four men to drag it into the geographer's study. Abu Abdallah Mohammed Idrisi spent the next fifteen years at work, drawing, engraving, minting and pressing the contours of the lands known to him and to King Roger on the precious metal.

King Roger died before the map was finished. But the geographer carried on. The map was all that they had hoped for – all the countries, mountains, seas and rivers, all the deserts stood out clearly. And there was an excellent key to the map in script.

Alas, both the king and the geographer had made one mistake. The silver was not that durable. When the king's heirs needed money, the silver map disappeared. We would not even have known about it, had not Ibn-Idrisi made copies on ordinary paper. They served people faithfully and have survived to the present day. So which do you think would last longer, silver or ordinary paper?

The Arab geographer's map included everything that was known about the world in the twelfth century. But knowledge at that time was limited, so it also included a great deal that had been invented. When people do not know something, they often fill in with what they think should be there.

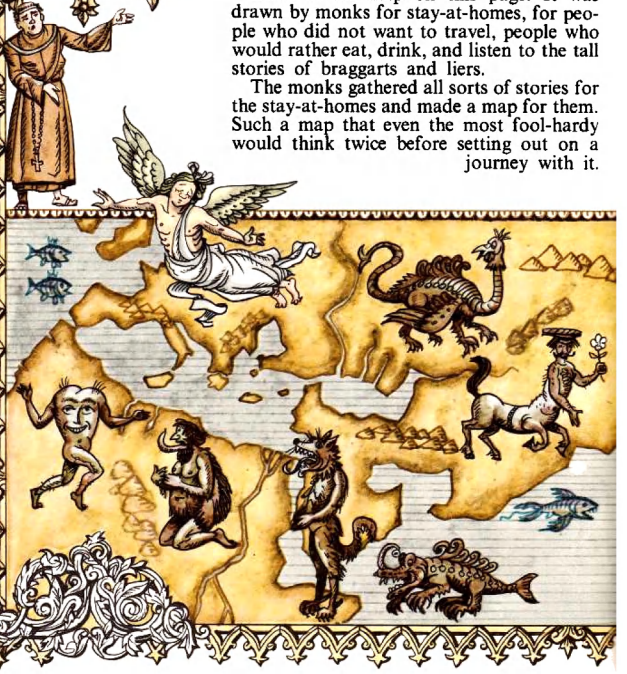
Ibn-Idrisi and King Roger's map included many things that never were. But though we can see mistakes eight centuries ago no one would have questioned them.

A Map for the Stay-at-Home

People who never go anywhere have few questions. Either they think the whole world is like the street they live in, or else they will believe any story, however far-fetched.

Look at the map on this page. It was drawn by monks for stay-at-homes, for people who did not want to travel, people who would rather eat, drink, and listen to the tall stories of braggarts and liers.

The monks gathered all sorts of stories for the stay-at-homes and made a map for them. Such a map that even the most fool-hardy would think twice before setting out on a journey with it.



There is the story of the one-legged man. No, not a cripple. A whole tribe of one-legs who, a traveller had told the monks, lived in a distant part of India. They could hop very fast. And when it rained, they put their one leg up and used it as an umbrella.

India, according to these tellers of tall stories was also the home of people with dog's heads, with horse's legs and even a miserable race who had no mouths. These last lived beside the river Ganges and fed on smells. If they set out on a journey, they would tuck an apple inside their shirts because the smell would keep.





In Africa, according to the monks, there was a headless race of people, whose eyes, nose and ears were on their chests... Then there were giants on the map whose ears were so big that they could roll up in them like blankets. And a big-lipped tribe could use their bottom lips as sunshades.

There were all kinds of frights, monsters, dwarves and giants and dragons from fairy-tales and legends on this ridiculous map. So people in the safety of their homes could enjoy talking about these frightful monsters that lay in wait for travellers in foreign lands.

Even in the middle ages literate people sometimes had translations of books by philosophers that explained how natural things happened without the agency of a God. As time passed, people gathered more and more information. And often the facts would challenge the story in their sacred writings that the Earth was flat.

Then came the event which finally proved that the Earth is round.

On the 20th of September, 1519, five Spanish ships left the Guadalquivir River mouth and headed south-west across the Atlantic for the Canary Islands and Brazil. The *Trinidad*, their flag-ship, carried the Commander of the expedition – Ferdinand Magellan. He had promised the King of Spain that he would reach the spice islands in the far east by sailing west.

Three years later, on the 6th of September, 1522, the only remaining ship of the expedition, the *Victoria*, sailed up the Guadalquivir under the command of the helmsman Juan Sebastian de Elcano. She had sailed right round the world. It was the first ever voyage round the world. And that finally proved that the Earth is round.



While traders sailed in inland seas or stayed in coastal waters, most captains did not worry about the shape of the Earth. But the farther they sailed from their own shores, the more mistakes had to be corrected on maps that had been drawn without considering the shape of the surface.

The fifteenth century was a time of great geographical discoveries. Sailing ships no longer hugged the coastlines. They headed out across the oceans. Such journeys took incredible courage. You will soon see why.

Nowadays schoolchildren in every country know that the position of any place on Earth can be fixed by two coordinates – latitude and longitude. The latitude, the distance from the equator, is measured in degrees, naught to ninety north or south of the equator. Look at













the figure, and you will see that it is quite easy.

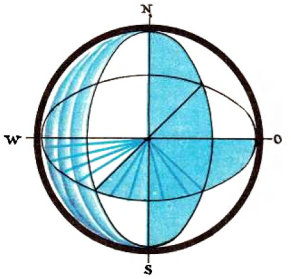
Latitude can be checked from the height of the Polar Star at night, or the sun at noon. Sailors have had special instruments for this for a long time. They are called the sextant, the astrolabe and the quadrant. They made it possible to measure the height of the heavenly bodies from the deck of a ship at sea.

The longitude was a bit more tricky. Longitude is the angle between the plane of the meridian we are on and the plane of the prime meridian, the one that passes through the Greenwich Observatory in Great Britain, the one defined as zero.

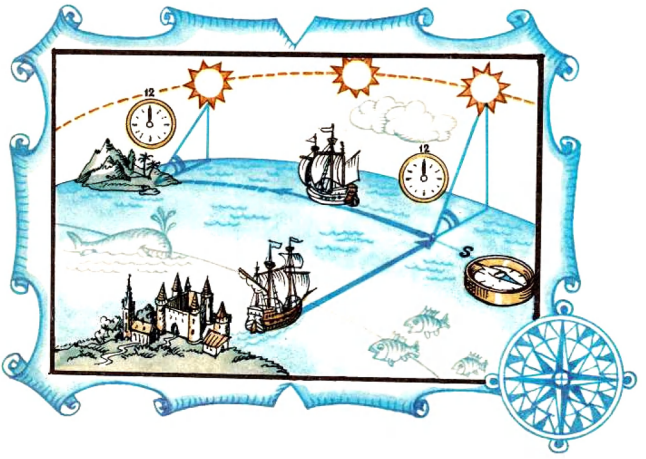
The prime meridian divides the world into Western and Eastern Hemispheres, while the equator divides it into two halves, 180° degrees each. (Remember that a full circle equals 360° degrees). Thus the meridians, which are numbered 1° up to 180° east or west, define longitude to the east and west of the prime meridian. Look at the figure and you will see it for yourself.

But how can one find out the longitude in the open sea? It took several centuries before anyone found the answer. The early seafarers could only be certain of the latitude.


Ferdinand Magellan



It is interesting to see how navigators laid their course. Suppose it was necessary to steer a course south-west from Portugal, across the ocean to a certain island. The captain would find out the height of the sun at noon at the latitude of the port of destination. He would steer due south by compass until the height of the sun at noon was correct. Then the captain would order a 90° turn west and stay on that latitude until he reached the island. He could stay on the right latitude by checking the height of the sun at noon.



If you play chess, you will notice that this is rather like the way the knight moves. Obviously it is not the shortest route for a ship.

The governments of many countries set up special commissions and promised big rewards for a practical method of checking longitude at sea.

However, no one found an answer. All the methods suggested were inaccurate or else too complicated.

The problem was not solved until the chronometer was invented. This is a very accurate ship's clock which can keep accurate time, the time of the prime meridian, for the whole voyage. Then you could calculate the difference between Greenwich Mean Time (at the prime meridian) and local time. For people had been able to find out when it was noon (local time) anywhere from time immemorial.

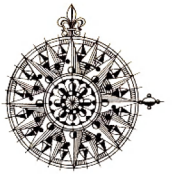
How to transfer the coordinates of the spherical globe onto a flat surface – a map – is yet another problem. How can you draw an accurate map on a flat sheet of paper?

Try spreading out the skin of a balloon or of a football flat on the table. You will soon find out that the only way to do it is to cut it into strips. And the narrower the strips the better they fit.

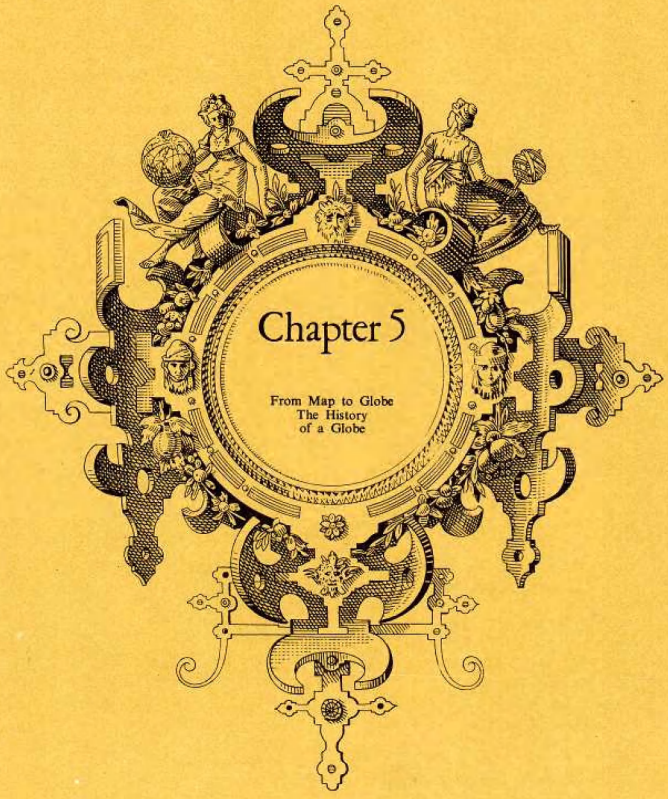
But who wants a map cut up like noodles? It would be rather difficult to use. Yet there were times when people did use such maps. They were drawn on narrow wedges as if stripped off a globe. People tried all sorts of ways of representing the curved surface. Eventually the fascinating business of map-making – cartography – became a science in its own right. You cannot make a curved surface flat. So cartographers have had to take it up. They thought up many different projections. Some left the lengths along the equator, but changed them as they moved away from it. Others left the meridians unchanged and distorted the shape and areas of continents. Still others tried to keep the size of the continents in proportion to their actual values, but... And so on.

You can see some projections in figures? Take a good look at them.

Perhaps one of you might be a ship's captain one day. Then you will need to remember some of these projections...

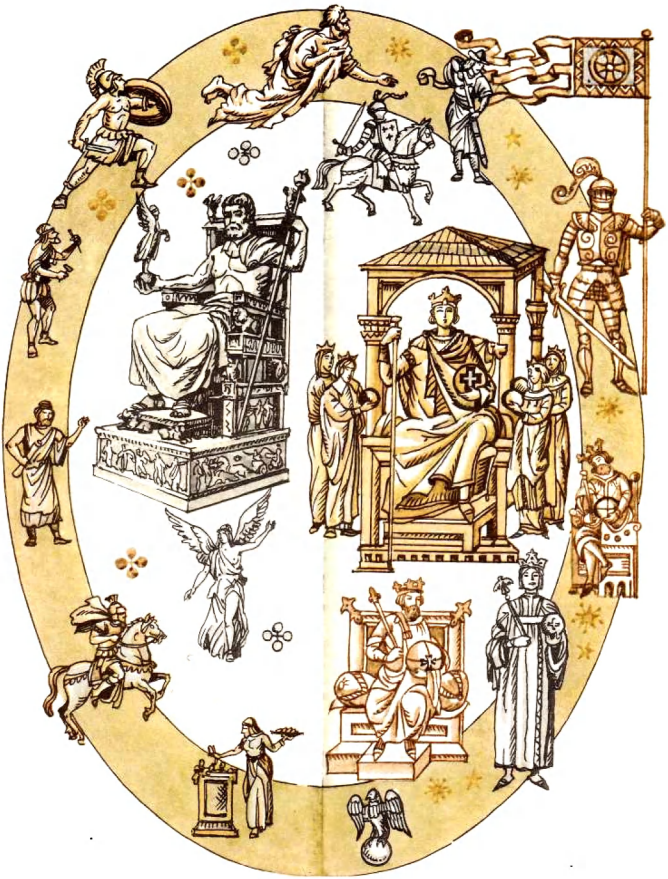






Chapter 5

From Map to Globe
The History
of a Globe



Long ago, some one hundred and fifty years B.C., the ancient Greek philosopher Crates of Mallus built a model of the Earth. It was a sphere. Crates, you see, was a follower of Aristotle and of his disciples. Unfortunately, the model has not survived. But people who saw it said that Crates had only drawn dry land divided into parts by rivers he named oceans. Of course, one could hardly call this model a real globe. For a real globe is an exact model of the Earth including all the continents and oceans known to people at that time. Crates' globe was not a model but a symbol. And although later people went back to the belief that the Earth is flat, the Roman and Byzantine emperors were the first who used Crates' globe (called the orb) with its crossing bands of oceans as the symbol of their power in the world. The Romans crowned their orb with a figure of the goddess of victory, while Christians crowned it with a cross. Since that time, the orb has become indispensable in the regalia of kings, a symbol of imperial power. Nowadays, orbs are stored in museums as works of art and treasure because they were usually made of gold and jewels by some of the best artists of the time.

The first real globe appeared in Europe in the fifteenth century. Once, in the old German town Nuremberg, a man called Martin Behaim went to visit his father, a local cloth merchant. His parents had wanted him to take up his father's trade. But Martin had become a seafarer. He had learned mathematics, become a good sailor and taken service with King Juan II of Portugal. The king granted him knighthood.





Of course, the newly made noble wanted to visit his home to show off his success abroad to his family and his neighbours. The Nurembergers listened to Martin's stories open-mouthed. He had been "round a third of the world". Most of them did not even suspect that the world was round. They asked Martin to draw something of what he had seen on his travels for them as a keepsake. Martin agreed. He asked them to have a big wooden ball made, one foot eight inches in diameter. Then he pasted parchment on it on which he had drawn everything he had seen and heard of. And he wrote things under the

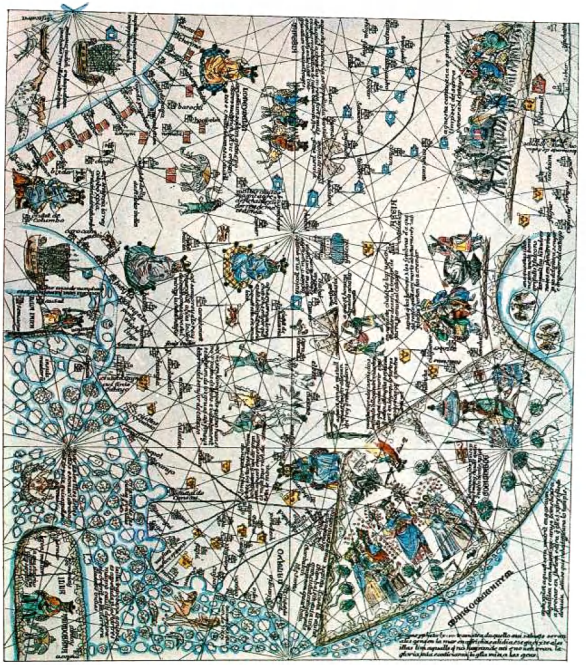
drawings. It might have been better without the working. He wrote such fanciful stories on it in red and black ink that later on Nurembergers were ashamed of the present and tried to keep it hidden. Many well-known places were placed at the wrong latitude on Martin Behaim's globe, mistakes that were no longer made even on the simplest maps. As for more distant places, the globe was quite absurd. For instance, Martin had put a whole archipelago of islands where America should have been and had written in that very big people lived there, each four or even five times as big as ordinary man. These people, so he wrote, went around naked, had long ears, wide mouths, frightful big eyes and arms four times as long as normal.

He populated Java with people with tails. And in Japan, which he called Zipango, he placed sea monsters, mermaids and other fish-people.

But his globe, called "the apple of the Earth" was brightly painted. A king sat on the throne in every country, and there were flags and bright insignia everywhere. In the Southern Hemisphere, which was almost unknown to travellers of that time, Martin wrote the history of the creation of his globe.

Martin Behaim's globe was followed by many globes in other countries. They were expensive, bulky and not very useful for finding your way. However, they were very well suited for learning navigation, so many craftsmen made globes. Some of them were quite extraordinary. Let me tell you about one such globe.





An ancient map

The History of a Globe



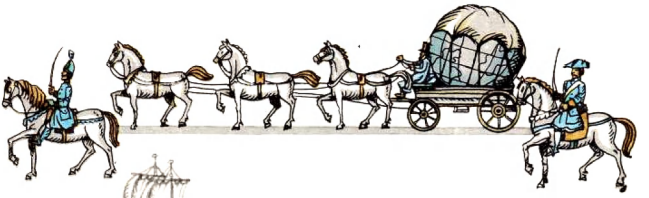
In Leningrad, USSR, on the banks of the River Neva, there is an old building with a tower. This was the first Russian museum, the Kunstkammer. A big academic globe is kept on the fifth floor of the tower.

Let me tell you its history. It was written down in great detail by Professor Rudolf Its, a Leningrad scholar.

On a late autumn evening 1713, bright lights lit up the windows of the Gottorp Castle in the German duchy Schleswig-Holstein. The castle on river island Schlai, was a good fort, but it was besieged by the Swedish army. The Russian armies came to the rescue of the Duke and they drove back the Swedes together. The Regent, the young duke's guardian, threw a party. The Regent knew that the Russian Tsar – Peter the Great, was there among the Russian officers, and he knew that Peter was interested in curios. The Regent led Peter from hall to hall showing him collections. The Tsar admired them, but walked round without stopping. Then suddenly he did stop. In a large, dark hall there was a huge globe, more than three metres in diameter. It was made of wood and pasted over with paper with the continents and all the islands then known in Europe painted in bright colours.









Peter was still more surprised when his host opened a small door and invited his guest to step inside the globe. The axis of the globe ran through a central table with a bench round it. The walls were painted purple with copper stars nailed on.

The Tsar really liked the globe. Then the Regent gave a sign and the globe rotated slowly like the Earth itself. The Tsar was enchanted. He was eager to acquire it to use for teaching Russian seamen navigation. You can imagine how pleased he was when several days later he received the globe as a present, in gratitude for relieving the castle from the Swedish siege.

It was a long and difficult journey for the German globe. It took four years to get it to St. Petersburg, the Russian capital. First it went by sea, then it was loaded on a huge sledge pulled by horses through lanes cut in the forests, bypassing marshes and ravines. When the globe finally arrived, it was placed in a booth that had been specially built.

After Peter's death, the globe was taken to the tower of the Kunstkammer which had just been built.

Twenty years later a big fire damaged the Kunstkammer collection, and all but destroyed the Gottorp globe.

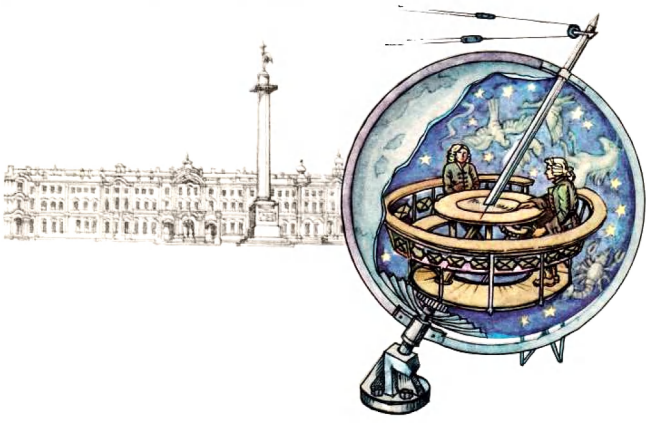
For a long time no one could be found to

restore it. At last, the Russian craftsman Tiryutin did it with a few assistants. He made a new body and repaired and improved the turning mechanism. Then he put round two yellow copper hoops for the equator and the prime meridian. When this was done artists were brought in. There were quite a few changes, because in the hundred years since the globe was made many new things had been discovered.

The inside walls were painted azure. The constellations were drawn and gilded and stars were nailed on. The globe looked better than before!

In 1901, the globe was transported to Tsarskoye Selo (now Pushkin). During the last war, the city was occupied by nazi troops. When Soviet soldiers liberated Pushkin from the invaders, there was no sign of the globe anywhere. After a long, long search it was discovered in the German town of Lübeck where the nazis had taken it.



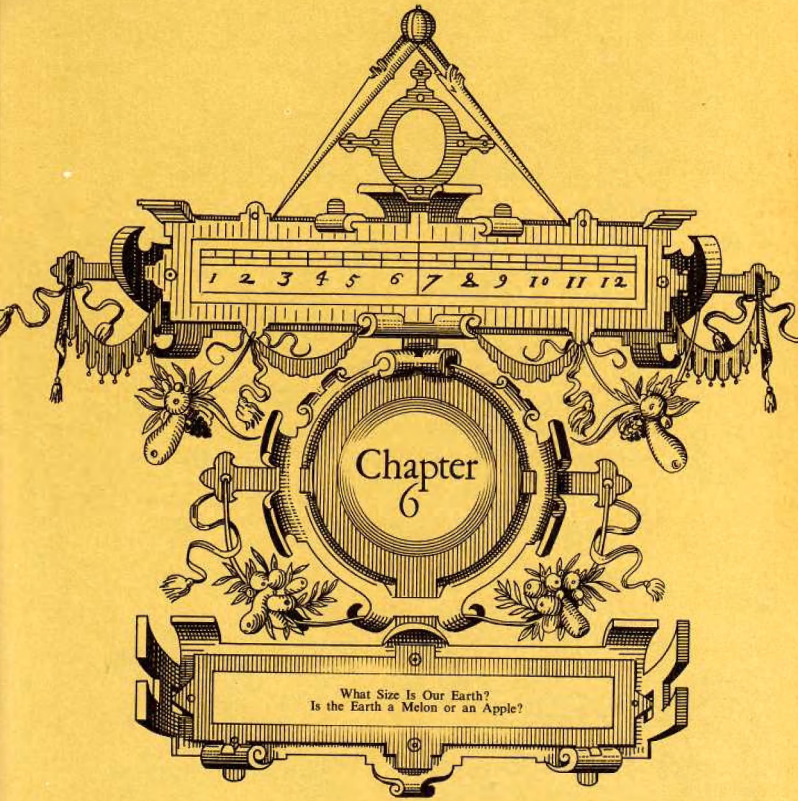


So once again, like two hundred years ago, the globe, this time the Tiryutinsky globe, was loaded on a ship. A special railway platform was built in the port of Arkhangelsk to take the traveller back to Leningrad.

In 1948, a hole was cut into the wall of the Kunstkammer tower. A crane lifted the Big Academic Globe, made by a Russian craftsman, to the fifth floor, where it has rested safely ever since.

If you ever happen to be in Leningrad, do go to the Kunstkammer. You will certainly not regret it.




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Chapter
6
What Size Is Our Earth?
Is the Earth a Melon or an Apple?


ΡΟΔΟΣ

Since olden times people have wanted to know the shape and size of their planet. Many scientists repeated Eratosthenes' attempt to find this out. Their results varied considerably. Posidonius, an ancient Greek philosopher and mathematician, first checked how long it took a ship to sail from Rhodes to Alexandria. Then he calculated the height in the night sky of the Canopus star and from this calculated the circumference of the Earth. But his result was less accurate than Eratosthenes'.

A thousand years later, in 9 A.D., by the order of the Caliph Abdullah al Mamun, some Arab scientists in Mesopotamia tried their hand. Their calculations have been lost.

There have been several other attempts.

In the 16th century a French doctor fixed a counter to his carriage wheel to count the number of rotations between Paris and Amiens. He measured the height of the sun accurately at the beginning and end of the journey with wooden triangles and tried to make an estimate of the Earth's circumference from this. But the rough roads and his crude measuring techniques marred his results. A better method of measuring distance had to be found, which would not be affected by the roughness of the road.

Another hundred years passed before Willebrord Snell, a Dutch mathematician and astronomer came up with such a method. He called it "triangulation" from the Latin "triangulum"–triangle. When you learn trigonometry, you will find out how to do this. It is very interesting.

The fact that no two countries used the same unit of measure did not help either. The French used the "tois" (about six feet); the English–the yard (three feet); the Russians–sazhen (seven feet) and as for the Germans, well, Germany was divided into small principalities and the size



of the foot changed every time you crossed a border. Then there were miles: English, American, nautical and terrestrial and Russian versts as well. All this caused so much confusion that it was suggested that they should all be replaced by a single system. The French proposed a ten millionth of a quarter of a meridian and presently this became the legal standard measure in France. They called the unit a "metre".



Is the Earth a Melon or an Apple?

Do you know the difference between a melon and an apple? Not in taste, of course, in shape. Both are spheres, but the melon is stretched at nose and tail, while the apple is squashed. (Of course this is not true of every single one. Nature can produce both melons and apples in the oddest shapes but we are talking of the usual shape.)

Until the latter half of the 17th century everybody believed that the Earth was a perfect sphere. Then suddenly doubts arose. It all began when the Paris Academy of Sciences had meridian arches measured at several different points. The academicians came to the conclusion that the Earth was slightly elongated at the poles. That is, it was slightly melon-shaped.

The English scientist Isaac Newton did not agree. He calculated that it was flattened rather than elongated at the poles. The Dutch scientist Christian Huyghens supported Newton, arguing that since the Earth rotated around its own axis it must be slightly flattened. And to prove his point he stuck a large lump of wet clay on a stick on which he then rotated it very fast. Gradually it shaped itself into something like an apple.

The argument became heated. The French asserted: "The Earth is elongated at the poles." "Flattened, flattened," the English retorted. To settle the dispute an expedition had to be sent to measure the meridians. Further study produced evidence that the Earth is slightly flattened at the poles, but unevenly so.

The actual shape was finally determined in our time. On October 4, 1957, the first sputnik was launched in the USSR.







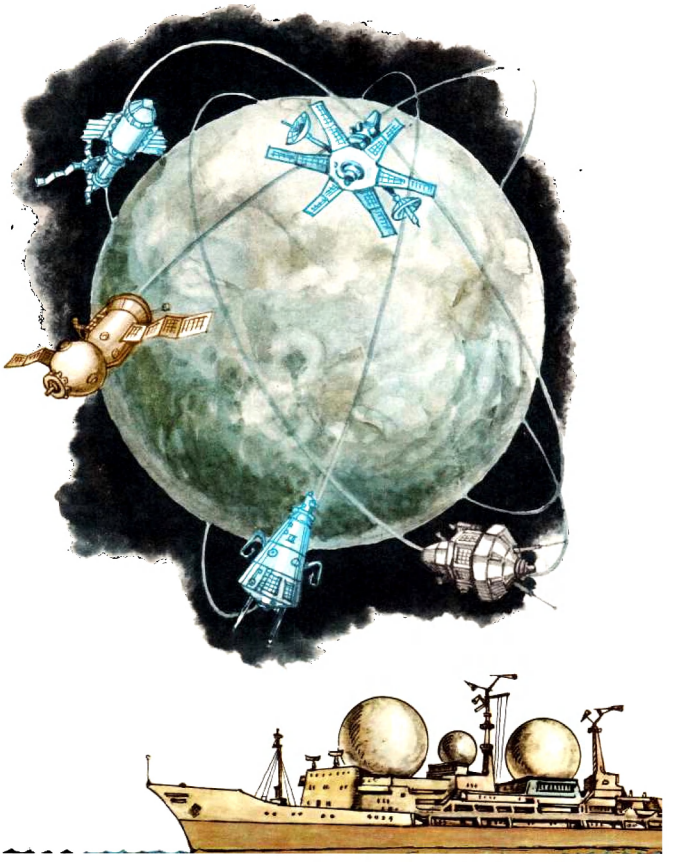
This was the beginning of the mastery of space. After this first trial, Soviet carrier rockets were launched one after another, and rivers of information began to flow in to the reception units at the remote control centres.

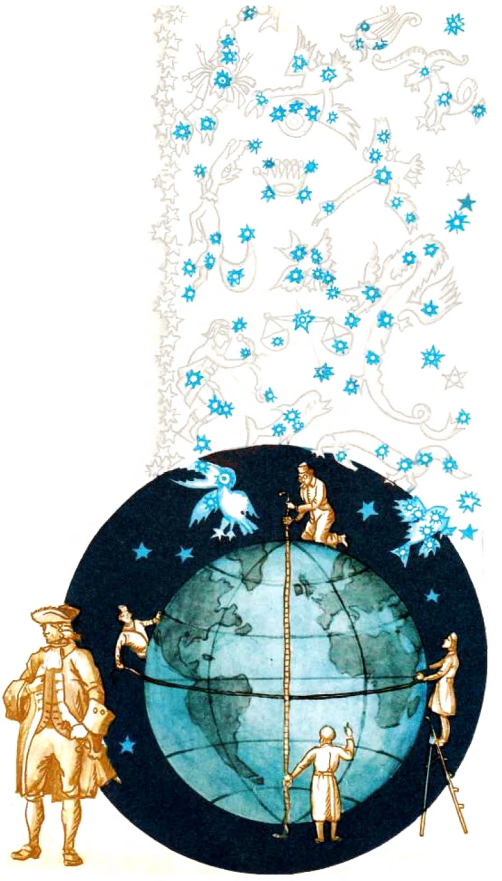
A year later the Americans put their first satellite into orbit. Scientists observing satellites in their elliptical orbits noticed that they all "dived" very slightly over the Northern Hemisphere. It was as if something was attracting them, though everything seemed normal in the Northern Hemisphere. Could it be Earth itself?

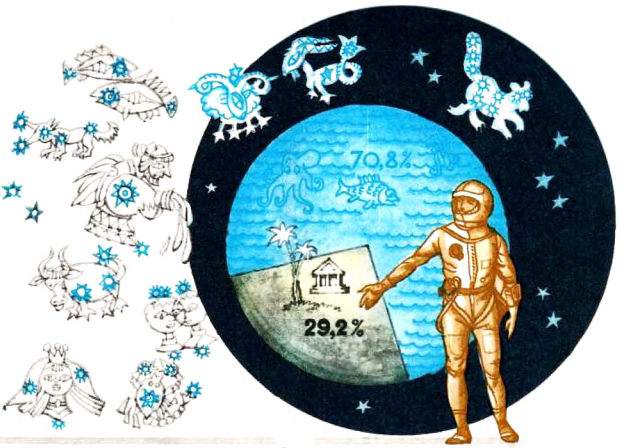
What with computers hard at work and satellites being launched from two continents, information accumulated apace. Soon the solution was found. The satellites detected bulges on two sides of the Earth: in the Indian Ocean in the south and near the American coast in the Northern Hemisphere. After a lot of measuring it was found that our planet is a trifle elongated in the Northern Hemisphere and a bit flattened in the Southern. So it is not an apple or a melon. Perhaps a trifle like a pear. But not a smooth or even one, the way they look in pictures. It is a little bit crooked and pitted on the skin.

So you couldn't really call it pear-shaped. Now the scientists have agreed on what to call the shape. They call it a "geoid", the name suggested at the end of the 18th century, which simply means "earthlike".

It is not a name that you can quarrel with. For even if we get a still more accurate picture in the future, the name will not have to be changed.







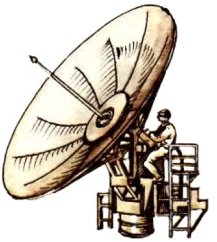
Conclusion

Today we take the polar radius of the Earth to be 6,356,780 metres. The equatorial radius is 21,380 metres longer. Of course in such a large radius twenty-one kilometres do not make much difference. But it does mean that the length of the equator, 40,075,160 metres, is 134,334 metres longer than the length of a meridian. And 134 kilometres, as you will agree, is quite a distance.

Today we can at least give definite anwers to the questions about the shape and size of our planet. We can even answer the question that caused big arguments among geographers, "Is there more water or land in the world?" For those who like exact figures here is the answer: there are 361 million square kilometres of sea on Earth. That equals 70.8% of the total area. So only 29.2% is land.

Now, today the well-being of our Earth depends on man himself. So it is your job and mine to look after our Earth, to work at making it a better and more comfortable place to live in.

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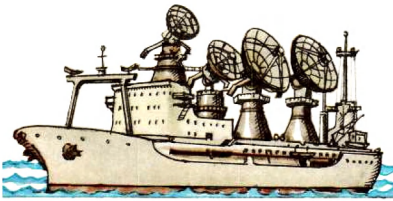
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А. Тонкинеев

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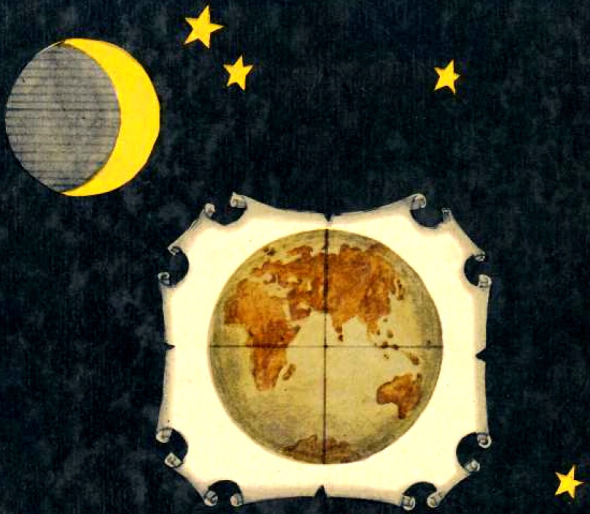
avec la representation des deux Emisphères Celestes, les Disques des Planetes. Dédiée à Messire BERTRAND RENÉ PALLU, Intendant de la



MAPPE-MONDE

du Soleil et de la Lune et les differents sentiments sur le mouvement de la Terre et Cours du Soleil de Lune, par un très habile et très célèbre Ingenieur BAILLEUL.





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